SPP 101
Our Mission

Helping our members work together to keep the lights on ... today and in the future.
Our Beginning

• Founded 1941 with 11 members
  – Utilities pooled electricity to power Arkansas aluminum plant needed for critical defense

• Maintained after WWII to continue benefits of regional coordination
The SPP Difference

• Relationship-based
• Member-driven
• Independence Through Diversity
• Evolutionary vs. Revolutionary
• Reliability and Economics Inseparable
Milestones

1968  Became NERC Regional Council
1980  Implemented telecommunications network
1991  Implemented operating reserve sharing
1994  Incorporated as nonprofit
1997  Implemented reliability coordination
1998  Implemented tariff administration
2004  Became FERC-approved Regional Transmission Organization
2007  Launched EIS market; became NERC Regional Entity
2009  Integrated Nebraska utilities
2010  FERC approved Highway/Byway cost allocation methodology and Integrated Transmission Planning Process
2012  Moved to new Corporate Center
2014  Launched Integrated Marketplace
2014  Became the regional Balancing Authority
SPP’s Corporate Center
SPP at a Glance

• Located in Little Rock

• About 600 employees

• Primary jobs — engineering, operations, settlements, and IT

• 24 x 7 operation

• Full redundancy and backup site
Community Involvement and Recognition

• Best Companies to Work for in Arkansas – Finalist (2013)
• Best Companies to Work for in Arkansas – Benchmark Award Winner (2014)
• Principal Financial Group “Top 10”
• Employee involvement, including:
  – Arkansas Foodbank
  – Girls of Promise
  – Race for the Cure
  – Relay for Life
  – United Way
  – Youth Home
Regulatory Environment

• Incorporated in Arkansas as 501(c)(6) nonprofit corporation

• FERC — Federal Energy Regulatory Commission
  – Regulated public utility
  – Regional Transmission Organization

• NERC — North American Electric Reliability Corporation
  – Founding member
  – Regional Entity
3 Electric Interconnections / 8 NERC Regions
Independent System Operator (ISO) / Regional Transmission Organization (RTO) Map
## Our Membership Profile

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
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<tbody>
<tr>
<td>Investor Owned Utilities</td>
<td>14</td>
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<tr>
<td>Cooperatives</td>
<td>13</td>
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<tr>
<td>Marketers</td>
<td>12</td>
</tr>
<tr>
<td>Municipals</td>
<td>11</td>
</tr>
<tr>
<td>Independent Power Producers/Wholesale Generation</td>
<td>13</td>
</tr>
<tr>
<td>Independent Transmission Companies</td>
<td>10</td>
</tr>
<tr>
<td>State Agencies</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>80</strong></td>
</tr>
</tbody>
</table>

As of October 28, 2014
Members in 9 states

Arkansas
Kansas
Louisiana
Mississippi
Missouri
Nebraska
New Mexico
Oklahoma
Texas
Operating Region

- 370,000 miles of service territory
- More than 15 million people
- 627 generating plants
- 4,103 substations
- 48,930 miles transmission:
  - 69 kV – 12,569 miles
  - 115 kV – 10,239 miles
  - 138 kV – 9,691 miles
  - 161 kV – 5,049 miles
  - 230 kV – 3,889 miles
  - 345 kV – 7,401 miles
  - 500 kV – 93 miles
2013 Energy Capacity and Consumption

Capacity

- Gas: 42.04%
- Coal: 34.08%
- Wind: 10.01%
- Hydro: 4.55%
- Dual Fuel: 4.06%
- Nuclear: 3.34%
- Fuel Oil: 1.83%
- Other: 0.08%

Consumption

- Coal: 61.2%
- Gas: 21.2%
- Wind: 10.8%
- Nuclear: 6.0%
- Hydro: 0.6%
- Diesel Fuel Oil (DFO): 0.3%

12% annual planning capacity requirement
Market Facts

- 127 participants
- 627 generating resources
- 2013 EIS transactions = $1.29 billion
  
  (Integrated Marketplace went live March 1, 2014)
- 46.3 GW coincident peak load
- 1,563 MW wholesale demand response
Transmission Facts

• In 2013, SPP members completed 101 transmission projects totaling more than $586 million

• More than $7.7 billion in transmission grid upgrades were planned and approved in the 2000-14 planning cycles

• 48,930 miles of transmission lines in SPP’s footprint would circle the earth — almost twice!
IT Facts

• 100,000+ data points updated every 4 - 30 seconds
• Operations model solves 33,650 x 80,548 matrix every two minutes
• More than 1,600 servers
• More than 1,100 terabytes of storage
Growth in Responsibilities

- Energy Imbalance Market Transactions ($MM)
- Transmission Customer Transactions ($MM)
- Number of Employees

Year-wise growth:
- 1998: 39
- 1999: 45
- 2000: 73
- 2001: 110
- 2002: 110
- 2003: 116
- 2004: 131
- 2005: 169
- 2006: 260
- 2007: 297
- 2008: 345
- 2009: 423
- 2010: 473
- 2011: 524
- 2012: 565
- 2013: 574
- 2014: 598

The graph shows a significant increase in energy transactions and number of employees from 1998 to 2014.
SPP Expenses: 2001-2014

Operating Expenses (in millions)

SPP Tariff Rate ($/MWh)
Interregional Coordination

- ISO-RTO Council
- Interregional planning efforts, including Eastern Interconnection Planning Collaborative
- North American Energy Standards Board
- National Association of Regulatory Utility Commissioners
Contract Services

• Alternative to RTO membership for Transmission Owners

• Oversight of Transmission Owners’ system operations:
  – Reliability Coordination
  – Transmission Planning
  – Tariff Administration
  – Interregional Coordination

• Provides process for assigning cost responsibility for transmission upgrades
Our Strategy

- Reliability Assurance
- Enhance Member Value and Affordability
- Optimize Interdependent Systems
- Maintain an Economical, Optimized Transmission System
Consumer Impact

- SPP cost = 67.5¢ of $100 residential utility bill
- Cost to typical residential customer for $1 billion of incremental transmission is ~$1.34 per month
- 2005 independent analysis by Charles River Associates:
  - $500,000 cost-benefit study
  - On behalf of state regulatory commissions
  - 270% ROI for SPP services during the next 10 years
SERVICES
Our Major Services

- Facilitation
- Reliability Coordination
- Transmission Service/Tariff Administration
- Market Operation
- Standards Setting
- Compliance Enforcement
- Transmission Planning
- Training
- Balancing Authority

Our Approach

- Regional
- Independent
- Cost-effective
- Focus on reliability
Reliability Coordination

- Monitor grid 24 x 365
- Anticipate problems
- Take preemptive action
- Coordinate regional response
- Independent

As “air traffic controllers,” our operators comply with ...

... more than 3,800 pages of reliability standards and criteria
Training

• 2013 Training program awarded more than 36,000 continuing education hours to more than 900 operators from 27 member companies

• SPP offers:
  – Regional System restoration drills
  – Integrated Marketplace Training
  – Regional Emergency Operations sessions
  – Train-the-Trainer classes
SPP Regional Entity

- Independent and functionally separate from SPP RTO
- Monitors and enforces Registered Entities' compliance with reliability standards
- Assesses and evaluates grid reliability
- Provides regional outreach on compliance issues
- Analyzes system events and develops Lessons Learned
Services

TRANSMISSION MARKET
What kind of markets does SPP operate?

• **Transmission Service**: Participants buy and sell use of regional transmission lines that are owned by different parties

• **Integrated Marketplace**: Participants buy and sell wholesale electricity in day-ahead and real-time
  – **Day Ahead Market** commits the most cost-effective and reliable mix of generation for the region
  – **Real-Time Balancing Market** economically dispatches generation to balance real-time generation and load, while ensuring system reliability.
Transmission Market

• Provides “one-stop shopping” for use of regional transmission lines
• Consistent rates, terms, conditions for all users
• Independent
• Process 10,000+ transactions/month
• 2013 transmission customer transactions = $1.29 billion

As “Sales agents,” we administer ...

... 3,000+ page transmission tariff on behalf of members and customers
Transmission Service

Without SPP

To get from a generator in Utility A to a customer in Utility C, electricity must flow through lines owned by Utilities A, B, and C, each with its own set of operating rules and associated costs.

$30

$4

$6

$5

$15 transmission service + $30 energy = $45
Transmission Service

With SPP

SPP moves electricity across Utilities A, B, and C in one transaction for a single service fee, then shares revenues with each party.

$5 transmission service + $30 energy = $35
How transmission service works

• Reserving transmission service
  – Like buying e-ticket to reserve seat on plane
  – Customer specifies priority, time, source/sink, capacity
  – Tariff administrator approves if capacity exists

• NERC Tag is issued
  – Like receiving boarding pass for plane
  – Won’t be approved if improper use of reservation

• Schedule is created from Tag. When approved:
  – Like sitting on the plane
  – Generators ramp to provide energy for transaction
  – May be curtailed if transmission system overloaded
WHOLESALE ENERGY MARKET
Finding Balance

More

Investment

Less

Minimum for Reliable Delivery to Customers

SPP Today

Expand Transmission

More Transmission Needed

Customer Energy Cost

No Limits to Low Cost Delivery

Less

Amount of Transmission

More

Finding Balance

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Market Concepts – What is a Market?

General Concepts:

- Buyers/Sellers OR Producers/Consumers
- Prices driven by Supply and Demand
- Products
Market Concepts – What is a Market? (cont’d.)

Wholesale Energy Market:

<table>
<thead>
<tr>
<th>Sellers/Producers</th>
<th>Buyers/Consumers</th>
<th>Locational Prices</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Utilities</td>
<td>• Utilities</td>
<td>• Driven by Supply and Demand at defined locations</td>
<td>• Energy</td>
</tr>
<tr>
<td>• Municipals</td>
<td>• Municipals</td>
<td></td>
<td>• Operating Reserves</td>
</tr>
<tr>
<td>• Independent Power Producers</td>
<td>• Load Serving Entities (LSEs)</td>
<td></td>
<td>• Congestion Rights</td>
</tr>
<tr>
<td>• Generators</td>
<td>• Power Marketers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Power Marketers</td>
<td></td>
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</tbody>
</table>
SPP’s Energy Market: Integrated Marketplace

1. SPP facilitates the Marketplace

✓ Provides the Infrastructure and Systems

✓ Maintains and follows 800+ pages of Marketplace Protocols

✓ 24/7 Market Operations
SPP’s Energy Market: Integrated Marketplace (cont’d.)

2. **SPP financially settles the Marketplace**
   - Calculates prices
   - Captures wholesale energy production and consumption
   - Collects from Market Participants (MPs) who owe the Market
   - Pays MPs who are owed by the Market
   - Remains Revenue Neutral

3. **SPP has an independent Market Monitor**
Independent monitors ensure markets operate as designed and are efficient/effective

- SPP’s internal Market Monitoring Unit (MMU) reports directly to the Board and Oversight Committee
  - Independent from SPP Regional Transmission Organization
- FERC Order 719 allows ISO/RTO markets to be overseen by internal, external, or hybrid monitor
  - 2 ISOs/RTOs have external, 2 have internal, 2 have hybrid
  - SPP’s use of internal MMU brings cost-savings and allows easy access to real-time operations
- MMU reviews real-time/historic data and reports any issues to FERC for investigation
Integrated Marketplace Overview

**Key Components**

- Day-Ahead (DA) Market
- Real-Time Balancing Market (RTBM)
- Transmission Congestion Rights (TCR) Market

**Products**

- Energy
- Operating Reserve (Regulation Up, Regulation Down, Spinning, Supplemental)
- Congestion Rights
Integrated Marketplace Benefits

- Net Benefits estimated at approximately $100 million/year based on Ventyx study
- Reduce total energy costs through centralized unit commitment while maintaining reliable operations
- Day-Ahead Market allows additional price assurance capability prior to real-time
- Operating Reserve products support implementation of the SPP Balancing Authority (BA) and facilitate reserve sharing
Day-Ahead Market

• Determines least-cost solution to meet Energy Bids and Reserve requirements

• Participants submit Offers and Bids to purchase and/or sell Energy and Operating Reserve:
  – Energy
  – Regulation-Up
  – Regulation-Down
  – Spinning Reserve
  – Supplemental Reserve
Real-Time Balancing Market

• Balances real-time load and generation committed by the Day-Ahead Market and Reliability Commitment processes

• Operates on continuous 5-minute basis
  – Calculates Dispatch Instructions for Energy and clears Operating Reserve by Resource

• Energy and Operating Reserve are co-optimized

• Settlements based on difference between results of RTBM process and Day-Ahead Market clearing

• Charges imposed on Market Participants for failure to deploy Energy and Operating Reserve as instructed
Transmission Congestion Rights (TCR) Market

• In the DA Market, price separation of MP’s resource to load may occur due to congestion leaving the MP exposed to high prices

• A TCR can be used as hedge against congestion that allows MPs to reduce their exposure to high market prices and potentially receive lower priced deliverable energy

• TCR Market has Annual and Monthly Auction processes related to two products:
  – Auction Revenue Rights (ARRs)
  – Transmission Congestion Rights (TCRs)
GRID CONGESTION
Impacts markets and transmission planning
What is congestion?

• Congestion or “bottlenecks” happen when you can’t get energy to customers along a certain path
  – Desired electricity flows exceed physical capability

• Congestion caused by:
  – Lack of transmission, often due to load growth
  – Line and generator maintenance outages
  – Unplanned outages such as storms or trees on lines
  – Too much generation pushed to grid in a particular location
  – Preferred energy source located far from customers

• Results in inability to use least-cost electricity to meet demand
Congestion prevents access to lower-cost generation
Congestion’s impact on Wholesale Market Prices

OSGCANBUSDEA – Osage Switch - Canyon East 115kV ftlo Bushland - Deaf Smith 230kv

North -> South flow in Texas Panhandle
SMP = $25.26 / MWh

North of constraint = $10.87 / MWh
South of constraint = $59.43 / MWh
TRANSMISSION PLANNING: BASIC CONCEPTS
U.S. Energy Consumption

Primary Energy Consumption by Source and Sector, 2012
(Quadrillion Btu)

Source
- Petroleum
  - 34.6 (36%)
- Natural Gas
  - 26.1 (27%)
- Coal
  - 17.3 (18%)
- Renewable Energy
  - 8.8 (9%)
- Nuclear Electric Power
  - 8.1 (8%)

Percent of Sources: Total = 95.0
- 72
- 23
- 5
- 1

Percent of Sectors
- Transportation
  - 26.7 (28%)
- Industrial
  - 20.6 (22%)
- Residential & Commercial
  - 9.6 (10%)
- Electric Power
  - 38.1 (40%)

“Manufacturing,” “transportation,” and “delivery” must occur instantaneously.
Other ways electric industry is unique

• Location of “manufacturing” plants is limited
  - Wind farms must be in areas of high wind, solar farms in areas with strong sun, hydroelectric plants on a river
  - Coal and natural gas can only be extracted where fuel is
    ▪ Coal mine may be far from coal-fired power plants – Expensive to transport coal long distances
    ▪ Location of coal and gas plants have limitations
• Manufacturing plants may be far from people, and “roads” may not exist to deliver product to consumers
• Some products are only available at certain times
Transmission planners consider:

• What parts of grid need strengthening to “keep the lights on”?
  – Redundancies necessary to account for a line being out

• Where are current and future generations located?

• Where are electricity consumers located?

• Where on the grid do we frequently see congestion (more traffic than roads can accommodate)?

• Will laws mandating more renewable energy or a carbon tax impact traffic?

• How do coal/gas prices impact traffic?
  – People will use more coal if gas prices rise, and vice versa

• How do regional temperatures impact traffic?
  – If temperature differs across region, one area may need more energy
Without transmission, we can’t deliver this capital-intensive generation to where it’s needed across region.
Transmission enables optimal use of our region’s diverse generating resources, including coal, natural gas, hydroelectric, nuclear, and wind energy
Larger transmission reduces Right of Way

- 345 kV
  - Six Single Circuit Towers
  - (900 ft. Right-of-Way)

- 765 kV
  - One Single Circuit Tower
  - (200 ft. Right-of-Way)

- 345 kV
  - Three Double Circuit Towers
  - (450 ft. Right-of-Way)
Services

TRANSMISSION PLANNING AT SPP
Why do we need more transmission?

• In the past, built least-cost transmission to meet local needs
• Today, proactively building “highways” to benefit region
How does SPP decide what and where transmission is needed?

- **Integrated Transmission Planning process**
- **Generation Interconnection Studies**
  - Determines transmission upgrades needed to connect new generation to electric grid
- **Aggregate Transmission Service Studies**
  - Determines transmission upgrades needed to transmit energy from new generation to load
  - Shares costs of studies and new transmission
- **Specific transmission studies**
Integrated Transmission Planning: Economics and Reliability Analysis

- Annual Near-Term plan
  - Reliability is primary focus
  - Identifies potential problems and needed upgrades
  - Coordinates with ITP10, ITP20, Aggregate and Generation Interconnection study processes

- ITP20
  - Develops 345 kV+ backbone for 20-year horizon
  - Studies broad range of possible futures

- ITP10
  - Analyzes transmission system for 10-year horizon
  - Establishes timing of ITP20 projects
Who pays for these transmission projects?

- **Sponsored**: Project owner builds and receives credit for use of transmission lines
- **Directly-assigned**: Project owner builds and is responsible for cost recovery and receives credit for use of transmission lines
- **Highway/Byway**: Most SPP projects paid for under this methodology

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Region Pays</th>
<th>Local Zone Pays</th>
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</thead>
<tbody>
<tr>
<td>300 kV and above</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>above 100 kV and below 300 kV</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>100 kV and below</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Transmission Owner Selection – Order 1000

• SPP developed the Transmission Owner Selection Process (TOSP) to allow competitive bidding on certain transmission projects.

• Transmission Facilities that meet the criteria in the SPP Tariff and are approved for construction (or are endorsed by the SPP Board of Directors) after Jan. 1, 2015, are known as Competitive Upgrades.

• SPP will solicit proposals for Competitive Upgrades from Qualified RFP Participants (QRP) utilizing the TOSP.
What role do state regulators play?

- Regional State Committee — Retail regulatory commissioners from:
  - Arkansas
  - Nebraska
  - Oklahoma
  - Kansas
  - New Mexico
  - Texas
  - Missouri
  - *Louisiana maintains active observer status*

- Primary responsibility for:
  - Cost allocation for transmission upgrades
  - Approach for regional resource adequacy
  - Allocation of transmission rights in SPP’s markets
Services

TRANSMISSION PLANNING MAPS
Projects Constructed 2005-2014
Approved Balanced Portfolio

Approved Balanced Portfolio
(Map as of July 2014)

All SPP Transmission Expansion Plans are subject to change.

- Completed 345 kV
- Portfolio 3-E
- Completed Substation
- Southwest Power Pool
- Woodward District EHV
Priority Projects

Priority Projects (July 2014)

All SPP Transmission Expansion Plans are subject to change.

- Transformer Upgrade
- Completed Substations
- Double Circuit PP
- Single Circuit PP
- 230 kV
- 345 kV
- 500 kV

Southwest Power Pool
230kV-plus Planned Expansion

All SPP Transmission Expansion Plans are subject to change.

- Completed 345 kV
- 230 kV Single Circuit NTC
- 345 kV Single Circuit NTC
- 345 kV Double Circuit NTC
- ITP20 Conversion/Reconductor
- ITP20 New Line
- Southwest Power Pool

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Proposed Expansion

Proposed Transmission Expansion in and Around SPP (345kV +) (July 2014)

All SPP Transmission Expansion Plans are subject to change.

- Approved Double Circuit 345 kV
- Approved Single Circuit 345 kV
- Draft EHV Overlay
- Ozark Study 345 kV
- Ozark Study 500 kV
- EWITS 345 kV HVDC
- EWITS 800 kV HVDC
- 345 kV Quanta/SPS
- 765 kV Quanta/SPS
- HPX
- CREZ Single Circuit
- CREZ Double Circuit
- Clean Line HVDC

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Conceptual and Approved Expansion

(Conceptual and Approved Expansion In and Around SPP)

(July 2014)

All SPP Transmission Expansion Plans are subject to change.

Upgrade Type
- Completed 345 kV
- Double Circuit 345 kV NTC's
- Single Circuit 345 kV NTC's
- Other Expansion
  - Clean Line
  - HPX Expansion
  - CREZ
  - SGL Ckt/Dbil Ckt Towers
  - Double Ckt

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Generating Resources

Distribution of Generation in SPP
(April 2014)

Generation Type
- Fossil
- Hydro
- Nuclear
- Wind

Voltage
- 230 kV
- 345 kV
- 500 kV

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WIND ENERGY
Wind Energy Development

- Wind “Saudi Arabia”: Kansas, Oklahoma, Nebraska, Texas Panhandle, New Mexico
  - 60,000-90,000 MW potential
  - More wind energy than SPP uses during peak demand
- 9,000 MW capacity of in-service wind
- 20,228 MW wind in-service and being developed
  - Includes wind in Generation Interconnection queue and with executed Interconnection Agreements
Annual Average Wind Speed - 80 meters

Solar in the U.S.

PV Solar Radiation
(Flat Plate, Facing South, Latitude Tilt)

This data represents annual average solar resource potential for 48 Contiguous United States and Hawaii, in High Resolution. The data for Hawaii and the 48 contiguous states is a 10 km, satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005.

Source: National Renewable Energy Laboratory (NREL), U.S. Department of Energy
Challenges with developing wind energy

- Intermittent
  - Must be supplemented with constant generating sources
- Wind in remote areas
  - Expensive new transmission needed
- “Not in my backyard” siting issues
- Seams agreements
- Renewable Energy Standards
Renewable Portfolio Standards

- NPPD, OPPD, LES goal
  - 20% - 2020

- KS RPS
  - 10% - 2011
  - 15% - 2016
  - 20% - 2020

- OK goal
  - 15% - 2015

- NM RPS
  - 6% - current
  - 10% - 2011

- MO RPS
  - 2% - 2011
  - 5% - 2014
  - 10% - 2018
  - 15% - 2021+

- TX RPS
  - 3,272 MW - 2009
  - 4,264 MW - 2011
  - 5,880 MW - 2015
  - 10,000 MW - 2025

n/a
Wind In Service

Wind Generation In Service
(October 2014)

All SPP Transmission Expansion Plans are subject to change.

Size of GI Request (MW)
- 1 - 60
- 61 - 140
- 141 - 250
- 251 - 550
- 551 - 1000

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Generation Interconnection Requests

GI Requests (Wind)
(As of October 2014)

Status of GI Request
- Signed IA/In Service
- Signed IA/On Schedule
- Signed IA/On Suspension
- Under Study

Size of GI Request (MW)
- 1 - 60
- 61 - 140
- 141 - 250
- 251 - 550
- 551 - 1000

All Generation Interconnection data taken from GI Queue on 10/2/2014

Request locations shown are approximate locations. Points of interconnection are not displayed on this map.

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